Performance-Based Environmental Restoration Management Assessment (PERMA):

Applying Decision Analysis to Implement Achievable Response-Action Completion Plans

Revision 1

January 2004

Issued by the Defense Logistics Agency

Executive Summary

This Guide is being issued by the Defense Logistics Agency (DLA) to clarify the requirements for implementing the Defense Environmental Restoration Program (DERP) at DLA installations. This Guide reflects DLA's continuing commitment to demonstrate and achieve protectiveness and to meet necessary, feasible, and reasonable environmental response-action obligations in the most effective and efficient manner possible. This Performance-Based Environmental Restoration Management Assessment (PERMA) Guide is designed to assist DLA environmental project teams to achieve response complete in a reasonable timeframe, while maintaining protectiveness of human health and the environment.

DLA issues this Guide also to clarify and stress the importance of remedy planning and optimization activities in establishing, reducing, and validating the annual environmental liability statement. The Guide reviews how to establish realistic and achievable performance objectives by taking advantage of the flexibility inherent in the DERP Guidance and the iterative nature of the cleanup program (i.e., five-year review process), as directed under the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) (as amended). Improving scientific and technical knowledge can and should be routinely integrated into the response-action planning and implementation process to ensure that the best responses are used to feasibly and reasonably achieve and efficiently sustain necessary protection.

This Guide requires environmental project teams to periodically validate whether response decisions are necessary to protect human health and the environment, and whether the approach used to provide that protection is feasible and reasonable to complete in a reasonable timeframe. DLA will use PERMA to establish, reduce, and validate DLA's environmental liabilities and schedules to response complete, in order to demonstrate measurable progress toward eliminating the need for Defense Environmental Restoration Account (DERA) funding.

This Guide describes procedures to validate that planned, or implemented, response-action decisions are achievable. By incorporating lessons learned and new knowledge, PERMA provides a means to:

- Define the environmental problem by updating the conceptual site model (CSM) in order to validate or refine the protectiveness requirements and options;
- Use comparative benefit/cost analysis techniques to verify use of the most effective and efficient means to achieve protectiveness and realistic completion goals in a reasonable timeframe;
- Use the statutory tests of performance to validate, and update if necessary, applicable or relevant and appropriate requirement (ARAR) analyses so that only necessary, feasible, and reasonable remedial action objectives and compliance commitments are pursued;
- Clarify performance criteria to be used to guide liability estimating and reporting;
- Ensure that documented progress is made toward response complete.

PERMA requires project teams to take full advantage of innovations in environmental and performance data collection and evaluation techniques to expedite effective and efficient completion of environmental response actions. Dynamic field and data-interpretation methods, transparent benefit/costs analyses, and performance-based cleanup contracting are examples of tools that can be used to implement PERMA.

This Guide was conceived by the Air Force Center for Environmental Excellence (AFCEE) and DLA, funded by DLA, and developed by Mitretek Systems.

Basis for Issuance

This Performance-Based Environmental Management Assessment (PERMA) Guide has been issued by the Defense Logistics Agency (DLA), with technical support from the Air Force Center for Environmental Excellence (AFCEE), to disseminate strategic information relevant to making and justifying protectiveness determinations. These protectiveness determinations are required to demonstrate completion of response-action obligations for sites subject to the Defense Environmental Restoration Program (DERP). This Guide is intended to clarify the need to incorporate and discuss evolving scientific and technical information on response-action requirements and remedy performance into realistic and achievable decisions for which protectiveness can be documented and completed in a reasonable timeframe. This Guide has been prepared to support achieving established Defense Planning Goals (DPGs) and ongoing efforts to evaluate and report on program execution, performance metrics, and fiscal requirements. This Guide is intended to supplement and clarify specific information provided within Department of Defense (DoD) Directive 4715.1, *Environmental Security*, February 24, 1996, DoD Instruction 4715.7, *Environmental Restoration Program*, April 22, 1996, and the *Management Guidance for the Defense Environmental Restoration Program*, September 28, 2001.

DLA is issuing this PERMA Guide as part of a self-auditing initiative to proactively identify optimization opportunities throughout its environmental restoration program by assessing and documenting response-action performance in accordance with the Government Performance and Results Act of 1993. DLA has invested in the development of this Guide as part of its ongoing commitment to provide strategic environmental management direction. This Guide has been prepared to help DLA environmental project teams assess and document remedy protectiveness, in order to achieve response complete in a reasonable timeframe, by taking advantage of the flexibility inherent in the DERP and its governing regulations. The performance- and results-focused tenets of PERMA—which are embodied in the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA), as amended—can be applied at any stage of an environmental program, from site assessment, risk analysis, and decision planning (i.e., selection of response-action objectives and the means to achieve those objectives), through response-action implementation, operation, and optimization.

This Guide is intended to help DLA environmental project teams 1) institutionalize into the decision process the various tests of performance recognized in the governing environmental statutes for Federal cleanup programs; 2) communicate clearly with involved stakeholders about the trade-offs inherent in any decision; and 3) use the iterative nature of the CERCLA cleanup program to improve response completion rates. The improvement of response completion rates is critical to reducing and efficiently managing DLA’s known environmental response liabilities. PERMA also explicitly considers resource balancing and decision consequences (trade-offs) as part of the analysis of applicable or relevant and appropriate requirements (ARARs) and periodic evaluations of the performance of different remedial components. DLA developed the information contained within this Guide pursuant to its roles and responsibilities related to engineering support, value engineering, systems analysis, and science and technical information management and analysis, as outlined in DoD Directive 5105.22, *Defense Logistics Agency*, December 6, 1988.

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Acronyms and Abbreviations

ACL	alternate concentration limit
AFCEE	Air Force Center for Environmental Excellence
AR	administrative record
ARAR	applicable or relevant and appropriate requirement
BACT	best available control technology
BCP	Base Realignment and Closure (BRAC) Cleanup Plan
CERCLA	Comprehensive Environmental Response, Compensation and Liability Act
CFR	Code of Federal Regulations
CSM	conceptual site model
CTC	cost-to-complete
DCA	decision consequence analysis
DERP	Defense Environmental Restoration Program
DLA	Defense Logistics Agency
DNAPL	dense, non-aqueous-phase liquid
DoD	US Department of Defense
DPG	defense planning goal
EMS	environmental management system
ERPIMS	Environmental Respiration Program Information Management System
GPRA	Government Performance and Results Act of 1993
ISO	instruction for standard operations
LUCIP	land use control implementation plan
MAP	management action plan
MCL	maximum contaminant level
MCLG	maximum contaminant level goal
NAPL	nonaqueous-phase liquid
NCP	National Oil and Hazardous Substances Contingency Plan
NEPA	National Environmental Policy Act of 1969
O&M	operations and maintenance
OSWER	USEPA's Office of Solid Waste and Emergency Response
PBC^2	performance-based cleanup contract
PERMA	performance-based environmental restoration management assessment
RAO	remedial action objective
RC	response complete
ROD	record of decision
RPO	restoration program optimization
§	Section [of regulation or statute]
SARA	Superfund Amendments and Reauthorization Act of 1986
SDWA	Safe Drinking Water Act
STC	schedule-to-complete
SVE	soil-vapor extraction
TBC	to-be-considered
USCA	United States Code
USEPA	US Environmental Protection Agency

Section 1

Introduction

The ultimate performance goal of the Defense Environmental Restoration Program (DERP) is to complete those response actions that are necessary, feasible, and reasonable to protect human health and the environment in a reasonable timeframe. A response action is not complete until reliable and sustainable protection of human health and the environment is assured (see, e.g., §104[c][6] of the Comprehensive Environmental Response, Compensation and Liability Act [CERCLA], as amended by the Superfund Amendments and Reauthorization Act [SARA]). While completion of actions required to assure protectiveness is the end goal of the environmental restoration program, demonstrating progress toward achieving protectiveness has been challenging. To better meet this challenge, DLA requires its environmental project teams to take a fresh look at their response-action decisions by taking full advantage of periodic performance assessment and course-correction opportunities afforded by CERCLA.

The technical knowledge base available to make response-action decisions has expanded dramatically over the past two decades. The experience gained through years of implementation of cleanup programs may now be used to validate the necessity, feasibility and reasonableness of certain response strategies. The intended outcome of these efforts is to document sustainable, reliable protectiveness so that the rate at which response actions are completed improves.

Completion of necessary, feasible, and reasonable response-action obligations at Federal facilities represents a true reduction in publicly-funded environmental response liabilities.

The Defense Logistics Agency (DLA), with technical support from the Air Force Center for Environmental Excellence (AFCEE), prepared this Guide to Performance-Based Environmental Restoration Management Assessment (PERMA) as an extension of its Restoration Program Optimization (RPO) initiative to proactively assess, document, and enhance performance of remedial programs at DLA installations, pursuant to the requirements of CERCLA and the Government Performance and Results Act of 1993 (GPRA). This Guide is provided to help DLA environmental project teams follow the basic tenets of CERCLA to:

- Compile and incorporate recently acquired and developed knowledge about the necessity, feasibility, and reasonableness of certain response-action decisions into realistic and achievable completion plans;
- Use a flexible decision model that includes specific decision criteria to refine and improve decisions through time; and
- Develop and present the site-specific evidence required to justify legally allowable flexibility regarding final remedial action objectives (RAOs) and effective and efficient means to achieve those RAOs.

The steps PERMA uses to ensure that reliable and sustainable protectiveness is achieved in a reasonable timeframe are: 1) identify the problem that may warrant response (Section 2), establish and validate necessary, feasible, and reasonable protectiveness objectives (Section 3), and 3) optimize the means used to achieve those objectives (Section 4).

1.1 The Road to Response Complete

A response-action decision includes performance objectives *and* the means used to achieve those performance objectives. The performance objectives of a response-action decision are the RAOs that must be achieved to assure sustainable, reliable protectiveness; the means used to achieve the performance objectives are the remedial actions or components.

RAOs also describe the site conditions to be achieved by the response action, in a reasonable timeframe, to ensure protectiveness. RAOs should be based on the results of the site-specific risk assessment and on analysis of applicable or relevant and appropriate requirements (ARARs).

By definition, until RAOs are achieved, human health and the environment are not reliably protected from potential harm due to exposure to site-related contamination. The decision authority (e.g., DLA) is obligated to continue response actions until human health and the environment are protected as required by the response-action decision; protection and completion of response-action obligations are measured by attainment of the RAOs.

In accordance with CERCLA, as amended, and all state environmental cleanup laws, the RAOs must be achievable in a reasonable timeframe to ensure that the decision results in timely, reliable protection. It is a waste of resources to pursue compliance with RAOs that are not necessary to ensure protectiveness. Similarly, the pursuit of RAOs that result in a greater risk to human health and the environment than the risk posed by current conditions is contrary to the intent of statutory and program mandates. It also is a waste of resources to implement infeasible, impracticable, or unreasonable means to secure sustainable, reliable protectiveness.

Thus, this Guide establishes that the performance objectives as well as the means used to achieve those performance objectives for all DLA projects completed under the DERP should be systematically and periodically evaluated for necessity, feasibility, and reasonableness to assure timely completion of response-action obligations. Such performance evaluations are required by CERCLA, as amended, and the DERP.

Focused performance evaluations will be used at DLA installations to define, refine, and complete those actions required to provide necessary and reliable protection of human health and the environment in a reasonable timeframe. DLA defines a reasonable timeframe to achieve response complete to be 10 years. DLA also intends to apply improving site and technical knowledge to validate or refine the RAOs and improve the performance of remedial components. This approach is consistent with the *Management Guidance for the DERP*, and is part of DLA's efforts to control, reduce, and efficiently manage known environmental response liabilities.

1.2 The Value of Emerging Knowledge

Knowledge about what realistically can be accomplished to provide protection, and "smarter and faster" ways to provide that protection, improves each year. Decisions made 5, 10, or 15 years ago do not reflect that improving knowledge base. Emerging exposure concerns (e.g., chemical vapor migration) and previously unaddressed chemicals of potential concern (e.g., perchlorate) are but two examples of how an evolving knowledge base could affect the basis and scope of earlier decisions.

DLA has recognized, during the course of implementing the DERP, that improving information on the necessity, feasibility, and reasonableness of certain response-action strategies may impact the effectiveness and efficiency with which response complete (RC) status is achieved. Specifically, DLA anticipates that evolving information on site conditions and remedy performance could be used to substantively improve the response-action decision itself.

Given that a decision consists of both performance objectives (i.e., the RAOs) and the means used to achieve those performance objectives (i.e., the remedial components), DLA developed this Guide to clarify the need to first focus on the performance objectives during remedy selection and remedy optimization activities. The objectives of a decision will drive selection of the means used to achieve those objectives. Consequently, the performance objectives are the foundation of the planning and implementation process. Refinements to the performance objectives may lead to refinements in the means used to achieve those objectives; conversely, new information about the performance of the means over time should trigger reassessment of the basis the decision (e.g., refinement of the CSM, clarification of the necessity, feasibility, and reasonableness of different types of performance objectives).

1.3 Cleanup Standards

Every response-action decision is defined by that level or standard of control selected as necessary to provide reliable protectiveness. Thus, the development of all potential performance objectives or RAOs begins with a site-specific risk assessment to define risk-based cleanup levels. However, in 1986, Congress amended CERCLA by adding Section 121(d) of SARA, which requires substantive compliance with Federal and state ARARs for onsite response actions. Congress added ARARs to the CERCLA risk-based framework to incorporate chemical-, activity-, and location-specific considerations that may need to be addressed by response decisions; this approach was intended to integrate different environmental requirements to promote the overall protectiveness of decisions both during implementation and following completion.

SARA intended ARARs to serve as decision guideposts, to ensure safe hazardous-substance management practices during response-action implementation and to establish appropriate cleanup, emissions, and discharge limits to offset adverse effects of the response actions themselves. ARARs basically are the means of verifying comprehensive protectiveness because pertinent standards can be used to validate the site-specific risk assessment and address other measures of protectiveness that typically are not addressed in the risk assessment (e.g., natural resource damage limitations, management of sensitive environments, and performance engineering stipulations).

However, efforts to comply with the substantive performance requirements of ARARs should not limit the flexibility inherent in the risk-based CERCLA program (US Environmental Protection Agency [USEPA], 1998). Rather, the risk assessment is the foundation of remedy selection, and ARARs are intended to scope the nature and extent of response actions that are necessary, feasible, and reasonable to ensure protectiveness **at a specific site** in a reasonable timeframe. The ARAR identification, evaluation, and selection process often controls the remedy selection and implementation process, and could control the time and cost required to demonstrate protectiveness (i.e., attain RAOs). Therefore, DLA, as the decision authority, must complete a thorough and site-specific ARAR analysis to ensure that the response decision incorporates:

- Only those performance commitments that are **necessary** to achieve and document sustainable, reliable protectiveness;
- A **feasible** means to achieve protectiveness in a reasonable timeframe, as indicated by site conditions, treatability data, and general remedy performance data; and
- A **reasonable** means to achieve protectiveness in a reasonable timeframe, as indicated by a site-specific benefit/cost evaluation.

To preserve and encourage tailored (site-specific) response actions, DLA environmental project teams are directed to routinely evaluate whether compliance with identified potential ARARs would lead to response actions that are necessary, feasible, and reasonable to protect human health and the environment. This kind of focused performance assessment hinges on providing substantial evidence to justify that protectiveness can be achieved and documented by either:

- Complying with the level of control specified by the ARARs (e.g., cleanup standards), or
- Complying with an alternative level of control (which may include an alternative point of compliance) in the situation where an identified ARAR does not reflect site-specific conditions or the knowledge base relevant to the cleanup program.

1.4 Statutory Tests of Performance

The RAOs establish the substantive compliance requirements that were judged to be necessary, feasible, and reasonable to achieve in a reasonable timeframe at the time the response-action was selected. CERCLA mandates that all potential ARARs that may form the basis of final RAOs should be rigorously and <u>iteratively</u> evaluated for necessity, feasibility, and reasonableness (*c.f.*, §121, especially §121[d][4]).

The record of decision (ROD) defines both the performance objectives and means to be used to effectively and efficiently achieve those performance objectives. Evaluations under DLA's RPO initiative have shown that improving knowledge often does not support the previously selected RAOs as necessary, feasible, and reasonable performance goals designed to provide reliable protection of human health and the environment in a reasonable timeframe (10 years). DLA is committed to timely compliance with protection standards. The intent is to control and reduce DLA's identified environmental response liabilities in the short term, and eventually transfer management of any residual liabilities into a single, integrated compliance program. Consequently, DLA invested in development of this Guide to clarify the importance of realistic and achievable RAOs, particularly for the following types of decisions:

- Response-action decisions driven by toxicity data or exposure assumptions that are the subject of considerable scientific debate;
- Response-action decisions driven by attempts to achieve a level or standard of control *in situ* based on Maximum Contaminant Levels (MCLs) or Maximum Contaminant Level Goals (MCLGs) established under the Safe Drinking Water Act (42 USCA §300f *et seq*.) and water quality criteria established under Section 304 or 303 of the Clean Water Act (33 USCA §1314 or §1313) for all impacted environmental media, particularly groundwater, with no clear and defensible demonstration of site-specific relevancy and appropriateness or protectiveness; and
- Response-action decisions derived using best-available-control-technology (BACT) strategies, where the performance means are "presumptively" established regardless of long-term uncertainties, contaminant source persistence, long-term maintenance costs, the potential for future remedial action costs should the remedy fail, and the potential threat to human health and the environment associated with extensive engineered containment and treatment activities (e.g., landfill containment, groundwater extraction and treatment, *in situ* thermal treatment of soils and groundwater).

DLA recommends periodically subjecting response-action decisions to the statutory tests of performance described within the ARAR waiver provisions (CERCLA §121[d][4]) to validate or refine proposed or established ARARs that may form the final RAOs (i.e. the completion criteria that must be met to achieve RC). This type of focused performance assessment should apply improving knowledge about site-specific conditions and remedial performance to establish achievable RAOs and response decisions for which protectiveness can be achieved and documented within a reasonable timeframe.

In issuing this Guide, DLA expects this level of evaluation to be completed as part of remedy selection, ongoing remedy evaluation and optimization efforts, and annual liability reporting (i.e., cost-to-complete estimates) to ensure implementation of practical, effective, and cost-efficient responses, as required by law. DLA intends environmental project teams to use the tests of performance to help routinely validate or improve response-action decisions during ongoing management and periodic performance evaluations, particularly for those types of decisions as listed above.

1.5 Integrating Lessons Learned: Making Flexible, Achievable Decisions

DLA developed this Guide to clarify the need to use improving knowledge to improve response-action decisions. DLA recognizes that sufficient performance data are now available to take the next evolutionary step in environmental decision-making: from framing and deterministic analysis, to probabilistic analysis and performance evaluation.

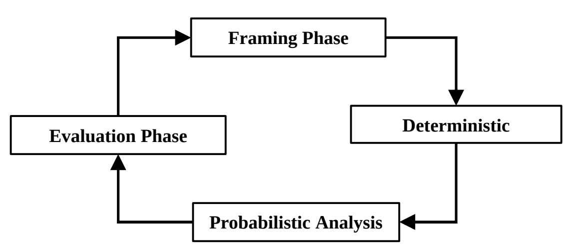

Figure 1. The evolutionary phases of decision-making.

In the first phase of decision-making, the environmental problem is framed so that satisfying alternatives can be identified and evaluated. This framing phase typically is completed as part of building the conceptual site model (CSM), which serves as a statement of the environmental problem that may warrant action.

The next phase of decision-making is deterministic analysis, wherein the values and preferences of the stakeholders are identified, and a decision/consequence model is used to illustrate the expected consequences of choosing different alternatives. The use of deterministic analysis techniques is well-grounded in the response-action selection process. The nine evaluation criteria developed by the USEPA (see 40 Code of Federal Register [CFR] 300.430[e][9][iii]) represent the values and preferences that should be considered when developing response decisions; the evaluation of different alternatives against these evaluation criteria represents one form of decision/consequence model.

PERMA allows environmental project teams to move beyond deterministic planning to flexible decision models that allow for different consequences or outcomes (i.e., probabilistic planning). By doing so, the environmental project team may be better prepared to address initially unplanned but not implausible outcomes of response-action decisions (e.g., failure to perform as expected and necessary to achieve RC status in a reasonable timeframe). A probabilistic decision model allows the environmental project team to plan for various probable outcomes of the remedial action by identifying performance metrics and decision criteria that will trigger implementation of an appropriate contingency alternative should the originally selected response action fail to perform as expected.

A probabilistic response-action decision may be represented as a decision tree. Decision trees are constructed to describe "if—then—because" actions that result from different probable outcomes. Decision trees provide for contingencies of varying remedial performance as part of the initial remedial decision. For example, if an implemented response-action decision is not performing as expected (i.e., if the hypothesis of successful performance in a reasonable timeframe is rejected), an alternative course of action is defined "upfront" to assure protection. Probabilistic planning may be compared to iterative hypothesis testing according to the scientific method. Improving knowledge about site conditions, response options, and risk can and should be used to improve/refine the response decision through time.

Probabilistic plans are much easier to evaluate, implement, and complete through time than deterministic plans because the specific performance metrics and decision criteria are clearly articulated, and improving site and technical information can be used to validate or improve the decision. These types of strategic, flexible decisions are similar to the strategic planning and implementation efforts being promoted by EPA as part of their Triad strategy. The more comprehensive the initial decision tree, the less likely the need to re-frame the decision to address unexpected outcomes.

DLA requires environmental project teams to use a probabilistic decision model to help achieve and document protectiveness, so that DLA can complete realistic and achievable response obligations in a reasonable timeframe. Planning and decision documents should define specific metrics and ranges of acceptable performance of remedial actions, and identify contingency actions to be taken if the performance metrics fall outside acceptable ranges.

1.6 RPO and PERMA

This Guide is intended to complement DLA's RPO initiative. This Guide emphasizes and clarifies certain concepts and approaches introduced in the RPO Handbook (AFCEE and DLA, 2001), and focuses on optimization of the ***basis*** of response-action decisions in order to document substantive protectiveness, so that projects can transition into verification of protectiveness. To capitalize on the institutionalization of RPO, as supported in Section 20 of DoD's *Management Guidance for the DERP*, PERMA builds upon the concepts of RPO and clarifies that the greatest potential for performance improvement lies in "optimizing" the RAOs using the statutory tests of performance.

DLA has adhered to the relative-risk prioritization policy established within the implementing guidance for the DERP, yet challenging environmental problems still remain to be addressed (e.g., groundwater contamination, landfills and other persistent sources, and emerging issues). DLA recognizes that legally allowed mandated efforts to optimize the performance of response-action decisions will require an iterative and integrated assessment of legal requirements in the context of expanding scientific and technological information.

DLA issued this Guide to formally require environmental project teams efforts to incorporate review and improvement of RAOs into environmental planning and periodic performance reviews. Thus, legal response obligations must be justified in the context of the expanding scientific and technical knowledge base, particularly at the most complex sites, where demonstrable progress toward protectiveness, as defined by current RAOs, may be below expectations.

Moreover, expanding optimization evaluations to explicitly include the basis of the response-action decision—as well as the implementing means—is in keeping with statutory requirements, legal obligations and authorities, and DoD expectations. PERMA emphasizes this often-overlooked aspect of the Federal cleanup program as part of its commitment to responsible use of public funds to assure protection of human health and the environment in a reasonable time-frame.

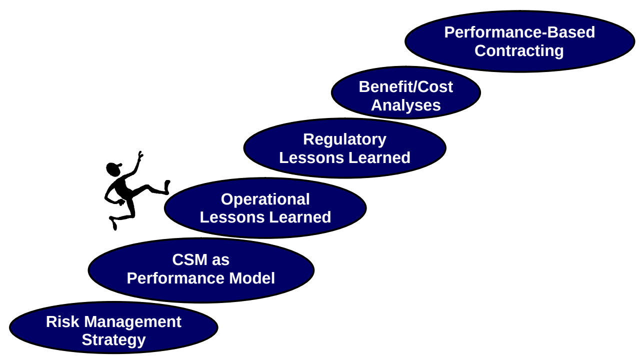

Figure 2. Steps to success using the major components of PERMA.

DLA anticipates that environmental project teams will use the concepts in this Guide to systematically focus response-action planning and implementation activities on intended outcomes (i.e., RC status) and the information to document progress toward that outcome (i.e., essential site-level data to substantiate cost-to-complete and schedule-to-complete estimates). DLA requires environmental project teams to conduct a response-action performance evaluation each year, in anticipation of the budget planning process, as a way to emphasize response-action performance and progress toward protectiveness achieved and RC.

Section 2

Defining Necessity, Feasibility, and Reasonableness

Assessing the performance of different response-action decisions hinges on defining and using defensible performance decision criteria. Criteria often used to evaluate response-action decisions center around costs incurred or avoided, schedule-to-complete, or other types of operational measurements (e.g., pounds of targeted contaminant removed from soil or groundwater). Yet, the most important performance objective for any response-action decision implemented under the DERP is **protectiveness.** Measuring and communicating progress toward the protection of human health and the environment requires that protection-related performance decision criteria be clearly identified as part of the decision process.

Appropriate and defensible performance decision criteria already have been specified and codified within the laws governing the Federal cleanup program. DLA has issued this Guide as a way of clarifying the importance of these statutory tests of performance when defining, refining, and completing decisions at DLA facilities. This section reviews the statutory tests of performance, and the types of measurable information that will be important in using these decision criteria.

2.1 Basic Information Needs

Most of the technical and legal information required by the statutory tests of performance can be located in the Administrative Record (AR) for any response-action decision. Considerable time and money are expended in the collection of data relevant to the selection, design, and implementation of any response action. This information, which may be stored within large databases, such as the Environmental Restoration Program Information Management System (ERPIMS) or project files, forms the foundation of the assumptions used to design the performance objectives of the decision, which are defined by both narrative and numeric RAOs, as documented in the ROD or an equivalent decision document.

DLA requires the environmental project team to critically evaluate the AR for completeness, with particular attention paid to the CSM (which is developed throughout the planning and implementation process) and the ROD, before subjecting the proposed or in-progress decision to the statutory tests of performance. The statutory tests of performance will require a well-articulated CSM, a site-specific risk assessment, performance data for proposed or implemented response technologies and strategies, estimated and realized cost information, and a summary of the assumptions or expectations driving the degree of cleanup and the ARAR identification process (e.g., land and resource use plans, practical and enforceable exposure controls, schedule-to-complete estimates).

DLA requires environmental project teams to adopt a facility-wide performance evaluation strategy, rather than a project-specific performance evaluation approach. By doing so, the project team lays the foundation for unifying response-action decisions made for different areas at a facility. This step will need to be taken to help re-integrate decisions that may have been segmented to support initial framing and deterministic analysis efforts. A comprehensive, facility-wide CSM leads to an integrated and comprehensive protectiveness determination. This is necessary because—in most instances—a determination that protectiveness has been achieved and response is complete ultimately will need to be made at the facility-level.

2.2 Summarize the Current Decision

Before the response-action decision can be evaluated using the statutory tests of performance, the environmental project team will need to prepare a brief description of the decision. This description should specifically include the following elements:

- Basis for the response (i.e., sources, nature, and extent of contamination; affected media; risk assessment results; land use; completed exposure pathways; and targeted contaminants);
- Estimated cost to construct the remedy, including management costs for non-engineered responses (typically available in pre-decision and/or decision documents);
- Construction-complete information, inclusive of schedule and cost (note that this information should be the sum of all funds obligated/spent to implement the response action, inclusive of management costs);
- Period of operation;
- System improvements, if any, inclusive of the basis, nature, and cost of these modifications;
- Monitoring requirements (both in surrounding affected media and as part of normal operation and maintenance [O&M] of the response action); and
- Related compliance requirements (e.g., decisions on the need for and scope of water/air treatment/discharge permits).

In addition, the environmental project team is required to develop a narrative description of how the proposed or implemented remedy integrates into the facility-wide cleanup effort, inclusive of the following information:

- Synopsis of site-specific cleanup strategy (i.e., how will the implemented response action facilitate achieving RC at both the site and facility level?);
- Summary of decisions made to date (i.e., status report on formal documented decisions relevant to both the site and the facility);
- Summary of pending decisions (e.g., outstanding data needs, formal remedial decisions); and
- Synopsis of other facility remedy components (e.g., land-use-control implementation plans [LUCIPs]).

Next, the environmental project team should develop a description of the performance objectives (i.e., intended outcome) of the implemented response action. Short-term performance objectives generally can be classified as operational design objectives. These performance objectives define **how** the response action is expected to perform in order to satisfy the final performance objective—protection of human health and the environment. Short-term objectives are defined by action-specific ARARs and the means used to pursue the long-term objective. Long-term remedy objectives are the narrative and numeric RAOs that are to be achieved in order to document sustainable, reliable protection and completion of response-action obligations (i.e., the completion criteria).

It is imperative that the environmental project team carefully evaluate the pre-decision and decision documents in the AR to construct a complete summary of performance objectives. These requirements represent the full nature and scope of the formal commitments proposed or made by DoD in terms of response-action obligations, and define the extent of substantive compliance requirements and environmental liabilities to be addressed under the DERP. These requirements also illustrate the current expectations of stakeholders with respect to the nature and degree of response that are necessary, feasible, and reasonable to complete in a reasonable timeframe.

2.3 Tests of Necessity: Exposure Potential and Points of Compliance

Performance decision criteria related to the ***necessity*** of any response action are set forth in the following two statutory tests of performance (CERCLA §121[d][4] and 40 Code of Federal Regulations [CFR] 300.430[f][1][ii][B]):

- Equivalent standard of performance, and
- Interim measures

DLA requires environmental project teams to verify that the proposed or implemented response-action decision is:

- **Necessary** to provide the degree of protection required by the risk assessment <u>and</u> ARARs (i.e., validate that protective cleanup standards are applicable or relevant and appropriate to achieve **at the established points of compliance**, which should be based on realistic exposure assumptions, improving toxicity and fate information, and point-of-compliance stipulations within the ARARs under consideration by the lead decision authority); and
- **Consistent** with other proposed or implemented response-actions required to provide protection (i.e., validate that the performance objectives and means used to achieve those performance objectives are internally consistent for each decision across a facility, accounting for current and future real-property management plans and enforceable resource use controls).

2.3.1 Measuring Protection

Developing and articulating a definition of "protectiveness" that can be presented to and understood by involved stakeholders is a crucial step in the tests of necessity. Protectiveness is a general concept that can be expressed by different criteria. DLA recommends using the following protectiveness criteria at DLA sites:

- Short-term protection (i.e., ability to prevent unacceptable exposure or continuing environmental releases into the environment immediately and during response);
- Long-term protection (i.e., effectiveness of response at reliably controlling exposure or recovering chemical mass from the environment);
- Permanence (i.e., ability to <u>sustain</u> reliable protection forever);
- Time (i.e., time required to demonstrate protectiveness and compliance with necessary legal response obligations); and
- Stakeholder acceptance (i.e., perceived expectations, such as preference for treatment over containment/control).

The metrics for protectiveness criteria should be developed and articulated as part of the **basis for taking action,** because this information is crucial to documenting initial performance expectations. DLA requires environmental project teams to carefully consider what information is available to help demonstrate that the primary threshold protectiveness criterion has been met. Or, stated another way, environmental project teams should incorporate available information into PERMA that is relevant to determining whether an alternative standard of control (or alternative RAO) would provide appropriate protection.

Most RODs stipulate that "protectiveness" will be measured using indirect (i.e., calculated or predictive) metrics, such as numeric standards developed as part of different regulations (e.g., MCLs established under the Safe Drinking Water Act [SDWA]). If indirect metrics are used, careful attention must be given to <u>where</u> performance is measured (i.e., the point of exposure is the necessary point of compliance).

Such an approach could shift the emphasis away from complete *in-situ* restoration using some relevant but indirect metric of protection, to technically achievable containment and treatment strategies that provide immediate point-of-exposure protection. This approach is legally allowable per the statutory tests of performance, as long as substantial evidence is available to demonstrate that an equivalent level of protection can be provided by an alternative standard of control (i.e., an alternative RAO).

2.3.2 Exposure Potential and Controls

The need for a response action is explicitly linked to receptor exposure potential. Response actions are only necessary to address conditions that pose a substantial or unacceptable risk- via a *completed* exposure pathway- to human health and/or the environment. Thus, assumptions about exposure are at the heart of the response-action decision process. The potential for exposure is considered for both the near term (current) and the long term (future).

Exposure pathways define how a particular receptor could come into contact with a chemical contaminant in the environment. In an exposure pathways analysis, the CSM uses chemical transport and fate information and assumptions about land uses and how receptors behave to identify ways in which those receptors could come into contact with different environmental media. It is important to note that some state environmental laws have attempted to define natural resources as potential receptors, to clarify that no exposure (i.e., degradation) is desirable. These state anti-degradation laws generally are designed to require waste control/containment activities, so that additional resources are not degraded; however, these anti-degradation laws typically do not apply to releases that occurred before the law went into effect. Environmental project teams should consult with legal counsel regarding the applicability of specific anti-degradation provisions to specific site conditions.

In the absence of direct measurements, many assumptions must be made to estimate potential exposure pathway completion. Receptor exposure pathways under current conditions do not require as many assumptions as those to be considered under future conditions. Because assumptions about what will happen in the long-term require some form of prediction about unknown conditions, exposure assumptions really should be expressed in terms of their probability of occurrence. Such an approach to exposure pathway analysis would transform human and ecological risk assessments from **deterministic** (i.e., there is one "right" answer) to **probabilistic** (i.e., there are a number of possible "right" answers).

Expressions of probability help stakeholders understand that there is a choice to be made with regard to how we best manage potential risk. Estimates of how future exposure potential may occur often are conservative, as they reflect an assumption that human behavior cannot be reliably controlled in the long-term. In fact, the entire remediation industry is built upon the assumption that engineered strategies to control contaminant behavior in the environment are more effective and cost-efficient than controls designed to limit human behavior. This is one of the initial assumptions underlying many response-action decisions that could be objectively verified or refined using years of engineering performance and cost data.

An example of this is the assumption that has generally been made about drinking water. This assumption is that the most effective way to protect human health from contaminants in groundwater is to remove the contaminants *in situ* such that the groundwater anywhere in the aquifer could be safely used for drinking without any further treatment. A corollary of this assumption is that the groundwater will be totally accessible in the future to the installation of a drinking water well anywhere in the aquifer. In reality, access to groundwater resources currently is controlled through a series of requirements ranging from well installation permits to wellhead withdrawal and treatment access rights. Water quality is monitored during well installation; depending upon its quality, additional treatment may be required before use. Such treatment is a legally required form of exposure control.

As long as the impacted resources are stabilized, either naturally or through engineered containment methods, these forms of *ex-situ* exposure control could serve to protect future receptors from exposure just as they do today. As long as the extent of the contamination is known and contained, this type of exposure control would accomplish protection of human health. In these cases, RC would be demonstrated by achieving reliable and sustainable exposure control (e.g., enforceable resource restrictions and/or point-of-compliance treatment); natural reductions in contaminant concentrations through time as a result of attenuation or withdrawal and treatment for beneficial use will occur such that those exposure controls may not be necessary eventually. The point is that RC status—which is attained when reliable protection has been achieved—is not tied to that eventuality. Projects could transition into verification monitoring only.

Yet these forms of exposure control—which are used to provide current protection—are rarely recognized as an option for future exposure control. As the environmental knowledge base continues to expand, DLA anticipates that environmental project teams will need to re-visit assumptions related to the statutory tests of necessity to validate or refine controlling assumptions related to engineering capability versus exposure control reliability. One of the key questions to ask during such assessments is: if exposure control responses are providing the necessary degree of protection today, why are exposure control responses insufficient to provide the necessary degree of protection tomorrow?

2.3.3 Points of Compliance

The point at which substantive compliance with necessary standards of "protectiveness" must be achieved is the point of compliance. The point of compliance should be the point of exposure. Again, assumptions about reasonable points of compliance are inherent in the tests of necessity.

The best examples of how important the defined points of compliance are to the nature and scope of final RAOs are the National Primary and Secondary Drinking Water Standards—as established at 40 CFR 141 in the SDWA. Drinking-water standards often are incorrectly identified as legally applicable requirements at CERCLA sites. For CERCLA actions, MCLs are legally applicable only when response actions impact public water systems that have at least 15 service connections or serve at least 25 year-round residents.

However, MCLs may be relevant as potential cleanup standards for on-site ground or surface water that is a current or potential source of drinking water (40 CFR 300.430[e][2][B] and [C]). Many states have codified the Federal SDWA standards into their state cleanup or groundwater protection programs as general "health-based criteria;" this action represents an effort to apply the level of control or treatment requirements afforded to potable public water supplies to all potential sources of potable water (e.g., groundwater). However, SDWA standards are not necessarily relevant <u>and</u> appropriate for all groundwater (see Section 3.3 of this Guide).

Evaluation of the relevance <u>and</u> appropriateness of identified ARARs is at the discretion of the lead decision agency (USEPA, 1998). Performance objectives that are defined by state re-interpretations of Federal drinking-water protection criteria (i.e., changing the point of compliance inherent in the definition of the Federal standard) could be tested for necessity, feasibility, and reasonableness, particularly as those interpretations may drive use of Federal funds. Information on land and resource use controls and the risk assessment could be used to resolve any site-specific issues related to the necessity of meeting different, policy-based interpretations of pertinent standards to ensure protection.

Finally, drinking-water standards (USEPA 1991) are derived under the following exposure assumptions:

- The source water will be used as residential tap water without treatment;
- Human receptors will drink 2 liters of the water per day; and
- **80%** of the allowable daily exposure to any specific chemical will be realized **from another source.**

If any of these assumptions is not valid for the source water in question, the relevance of these standards is subject to question, and an alternative standard of "protectiveness" (or alternative RAO) could be justified using the tests of necessity.

2.4 Test of Feasibility: Expected Influence on Natural Processes

Recognizing and documenting the significant limitations of currently available response-action technologies will be the basis of the test of feasibility. The statutory test of feasibility is recognized as part of the technical impracticability waiver provision (CERCLA §121[d][4] and 40 CFR 300.430[f][1][ii][B]). The test of feasibility applies to <u>both</u> the performance objective and the response action, although necessary protection should not be sacrificed as a result of a finding of infeasibility. The test of feasibility will involve documenting the effectiveness and efficiency of different response actions at influencing post-release natural environmental processes.

This Guide re-emphasizes statements made in the R*emedial Process Optimization Handbook* (AFCEE and DLA, 2001) regarding the need to understand what can feasibly be done to address impacted environmental resources. The growing body of remedy performance data should be used to improve response-action decisions—and to create a workable definition of success. The knowledge base was incomplete when the cleanup program began, and what could and could not be done in a reasonable (e.g., 10-year) timeframe to achieve reliable protectiveness was unclear.

DLA recommends that the test of feasibility be used to guide the compilation of site-specific technical evidence that is relevant to understanding what kind of past damage can feasibly be addressed in a reasonable timeframe using currently available means. This type of performance assessment involves integrating post-implementation remedy monitoring data with pre-decision planning information and assumptions to update the CSM.

2.4.1 Updating the CSM

The CSM should represent the current understanding of the physicochemical problems to be addressed by the response action. Information on the characteristics of the initial source, the mechanisms of release, the potential for receptor exposure, and the influence of natural processes that control the movement and fate of chemicals in the environment form the basis of decisions about what needs to be done, what can be done, and how best to do it.

DLA requires environmental project teams to update the CSM based on the most recent remedy performance and environmental monitoring data. Monitoring data collected during response-action implementation can provide valuable information about what processes are effective at influencing the movement and fate of site-related chemicals in impacted environmental media. The CSM should be sufficiently well developed to allow the team to determine why site conditions are as observed, and what feasibly could be done to influence those site conditions. Site conditions that could define the nature and extent of feasible RAOs, or limit the performance of different cleanup strategies taken to achieve those RAOs, should be identified to the extent possible. Remaining sources of uncertainty in the CSM also should be identified, and their potential impact on the success of the remedial decision should be assessed. At some sites, data collection to address identified data needs may be warranted. In such cases, improving data-collection strategies, such as the USEPA (2001) Triad approach, should be used.

Type and Condition of Source Waste

Chlorinated solvents are an example of contaminants that present challenges in finding feasible technologies for cleanup. The presence of chlorinated solvents in groundwater indicates that the chlorinated solvent was released in non-aqueous form at some point in the past. Chlorinated solvents are dense, nonaqueous-phase liquids (DNAPLs) (i.e., their density is greater than water, and their solubility in water is limited). DNAPLs tend to find their way to underground locations that may be both difficult to locate and infeasible to remove. The presence of DNAPL often is overlooked in the CSM. DNAPL is difficult to directly characterize at the field scale, so indirect indicators usually are used to estimate its potential occurrence. These indirect indicators can be useful for estimating the nature and extent of the DNAPL release, but the specific locations of the DNAPL source usually elude detection and characterization.

Except in rare cases—typically those where relatively low-mass releases have occurred—the presence of a persistent source (e.g., DNAPL) indicates that compliance with stringent RAOs at all points within an impacted aquifer will be infeasible. **Complete engineered removal of all forms of NAPL from the subsurface is not technically possible with today's technology,** which means that cleanup timeframes for these types of sites could extend into centuries.

Consequently, most sites contaminated with chlorinated solvents for which long-term performance objectives for groundwater have been defined using drinking-water standards have an extremely low probability of being able to document protectiveness or achieving RC status in a reasonable timeframe. These sites should almost always be addressed using a tailored response-action decision, inclusive of an ARAR analysis and performance objectives that incorporate the test of feasibility.

Metals in groundwater can present a similar problem. Metals often are mobilized in the presence of other chemicals, such as chlorinated solvents or petroleum products. Even undifferentiated organics, such as organic carbon found at inactive construction and debris landfills, can result in metals mobilization within groundwater. Although the geochemical basis for these relationships is beyond the scope of this Guide,. if the anthropogenic conditions that control metals release (e.g., organics releases) are infeasible to address, then the resultant metals release will also be infeasible to address in a reasonable timeframe. Care should be taken to ensure that the updated CSM reflects the current understanding of the physical, chemical, and biological processes that control chemical movement and fate, and thus pose such remedial challenges.

Landfills are another general category of source waste. Most landfill closure strategies are built around a BACT response-action decision strategy. That is, most landfills are addressed using a combination of containment and isolation techniques. Because no treatment is pursued, the timeframe required to achieve protectiveness, and complete the response action, should be defined by the time period required to validate reliable performance of the BACT.

Controls on Contaminant Fate

Many early CSMs did not completely articulate what natural processes are controlling the movement and fate of chemicals in the environment. Although physical processes such as advection, dispersion, and volatilization often are acknowledged in the CSM, limited information on chemical and biological controls is included. Consideration of this information is important because the chemical and biological processes may be responsible for limiting contaminant migration over time, and eventually stabilizing (containing) and reducing (treating) contaminant mass *in situ.*

The rate at which these natural attenuation processes affect stability and mass is site-specific. In some cases, these natural attenuation processes could ***interfere*** with the performance of the response action (e.g., adsorption versus extraction technologies). Yet natural attenuation processes also may afford the most reliable and sustainable form of control to contain and eventually remove chemicals *in situ*. Efforts to refine the performance objectives of the response action should be based on a technically credible explanation of natural attenuation potential, both in the short- and long-term. Natural attenuation processes will define the short- and long-term performance potential of any response-action means. **Natural attenuation processes are master controls on the feasibility** of different RAOs and the response means to achieve those RAOs in a reasonable timeframe.

2.4.2 Effectiveness of the Means

The effectiveness and efficiency of the means proposed or used to achieve the performance objectives of the response-action decision should be routinely evaluated for performance, and feasibility. The type of information that should be evaluated to investigate process effectiveness is detailed in the *Remedial Process Optimization Handbook* (AFCEE and DLA, 2001), so only a brief summary of issues to consider are presented in this Guide. DLA requires environmental project teams to consult the RPO Handbook and other appropriate references on how to check the performance of their selected response; this information will be critical to developing performance-focused closure plans for future use (also see Section 4 of this PERMA Guide).

Technology-Specific Lessons Learned

DLA expects environmental project teams to take advantage of the large body of knowledge now available about the short- and long-term performance of different remedial technologies. Project teams should not feel that their knowledge about remedy performance is confined to their experience at a particular site. Results from field-scale applications are potentially relevant at all sites with similar conditions.

This is the very approach that USEPA and state regulators have taken to enforce consistency in the response-action decision process. If the decision process as currently implemented results in the use of approaches that cannot achieve protectiveness in a reasonable timeframe, the decision itself must be revised. Project teams should use the growing body of knowledge about the very real limitations on remedy performance through time to help construct a workable definition of success.

Thus, DLA anticipates that environmental project teams will assemble and use information relevant to the general and site-specific performance of the response technology or strategy to examine and project the estimated effectiveness of the technology or approach at achieving the RAOs in a reasonable timeframe.

Site-Specific Effectiveness Evaluations

Effectiveness evaluations can best be completed by direct comparison of actual performance data to established performance criteria. Illustrations such as charts, graphs, and overlay maps are useful tools for evaluating these data. As a minimum, when evaluating the treatability or treatment performance of any response technology or strategy, the trend-analysis charts should be prepared to depict:

- Changes in concentration through time of one or more indicator contaminants at several key monitoring locations (e.g., Figure 3);
- The total mass of contaminants removed to date as a result of the response action, which should be presented in the context of original (or baseline) and residual mass to be addressed by ongoing response actions;

- Changes, if any, in response performance through time (e.g., rate of groundwater extraction *vs*. time); and
- Costs incurred to date (annual and total lifecycle) to make demonstrable progress toward final numeric RAOs (e.g., realized concentration changes).

The last graph should summarize how much the realized benefit has cost, and what should be the expected benefit/cost trend, assuming no significant changes in performance through time. These graphs are intended to help illustrate the past, present, and potential future performance of the response action at achieving timely completion of RAOs.

The goal of this kind of evaluation is to use temporal trend data to project long-term performance potential. **Near-term effectiveness improvements should be consistent with modifications required to document protectiveness and improve the rate of completing required response obligations**.

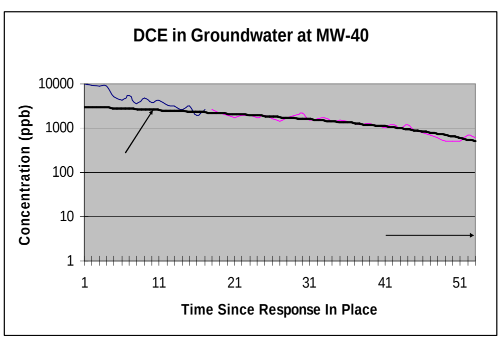

Figure 3. Temporal chemical data.

For example, optimization efforts should first determine whether the in-place response action is making measurable progress toward its intended objectives. To do this, the project team should extrapolate the temporal trend data over time to illustrate the rate of progress toward the targeted performance goal that can be achieved with the current response approach (Figure 3). If this extrapolation indicates that the proposed or implemented response-action decision cannot be completed in a reasonable timeframe based on the current rate of performance, the project team will need to identify what corrective actions may be warranted to facilitate completion, and why those actions are required and consistent with satisfying the overall objective of the DERP.

Using Contingency Waivers

In the absence of remedy performance data (e.g., early in the response-action decision process), DLA requires environmental project teams to consider the use of "contingency waivers" to incorporate an iterative test for feasibility into the decision (Office of Solid Waste and Emergency Response [OSWER] Directive 9234.2-01/FS-A). Contingency waivers, when explicitly included in decision documents, provide a way to document the intent to execute a probabilistic site completion strategy. Use of contingency waivers is one method of ensuring flexibility in the decision process by reserving the right to re-examine any element of the response decision in light of improving future knowledge, and to waive compliance with those elements that no longer satisfy the tests of performance through time. Such an approach allows improving site knowledge about the feasibility of achieving certain objectives to be incorporated, as necessary, into the completion plan for the site.

For example, if the CSM was not particularly well-developed at the time a decision was put into place, the performance of various response-action technologies over time could not be reliably predicted. The decision document could articulate the assumptions about performance and expected outcome that were made to select the decision, and also clarify what conditions would suggest that those assumptions were invalid.

Contingency waivers represent probabilistic decision planning in that the possibility of an unexpected outcome is recognized, and efficient alternative outcomes are identified as part of the formal decision. DLA seeks to formalize contingency planning by specifying the decision criteria (triggers) to be used to invoke an ARAR waiver on the basis of technical impracticability should the selected response action fail to perform as expected.

2.5 Test of Reasonableness: Maximizing Benefits and Managing Costs

The need to consider other tangible and intangible "benefits" and "costs" of certain decisions is a part of the response-action decision paradigm. The reasonableness of different choices that are not risk-driven will depend on the benefit/cost ratio. This term is used in this Guide to highlight the primary importance of focusing on the benefits (protectiveness) of any response decision, rather than the costs.

The final three statutory tests of performance provide for the test of reasonableness (CERCLA §121[d][4] and 40 CFR 300.430[f][1][ii][B]):

- Greater risk to human health and the environment;
- Fund-balancing; and
- Inconsistent application of a state standard.

Thus, the tests of reasonableness hinge on relative benefits as a function of full costs, and on consistency.

2.5.1 Greater Risk Test

Assessing the potential for greater risks to human health and the environment as part of performance assessments of response-action decisions is a concept not often applied within the Federal cleanup program. Response actions are planned to provide necessary protection, and ARARs are a means to ensure protection during response actions; the possibility of greater, unanticipated negative impact on human health or the environment typically is not addressed in response-action decisions.

This Guide requires a transparent assessment of the costs (or additional risks) to be incurred by taking action. This test of reasonableness is designed to check that targeted performance objectives or means to achieve those objectives actually result in a net benefit (i.e., high benefit/cost ratio). This test of reasonableness focuses on resource balancing, to ensure that the targeted "protectiveness" is not achieved at the expense of another important environmental value (e.g., recovery of water resources at the expense of air quality). Section 3 of this Guide illustrates how to use comparative benefit/cost ratios to establish performance objectives and emphasize effective/efficient remedial components.

Economic valuation techniques can be used to comparatively evaluate the full costs associated with different response-action decisions. However, attempts to monetize values relevant to protection plans (e.g., human life, clean water) may result in stakeholder confusion and controversy to such an extent as to interfere with the decision process itself. Thus, DLA recommends using simple qualitative ranking techniques to comparatively evaluate the benefits and costs of any decision, and to communicate the expected benefit/cost outcome of any decision to involved stakeholders. This approach builds upon the CERCLA remedy evaluation approach promoted by USEPA (e.g., USEPA, 1989a, 1997, and 1999).

Costs (or risks) to be incurred by any response-action strategy can be expressed as direct costs, indirect costs, and transactional costs. Direct costs are the easiest costs to identify and often are the only costs recorded in the decision planning process. Direct costs include capital costs, O&M costs required during response action implementation, and monitoring costs incurred both during implementation and following completion to verify protectiveness.

Indirect costs require a more complete decision consequence analysis; specifically, costs to environmental resources as a result of taking a specific action must be considered. DLA recommends recognizing at least five (5) major classes of indirect costs:

- Long-term costs incurred by using power to pursue protection, because such actions result in a reduction in overall available energy sources and increase power-related pollution (e.g., mining and drilling activities, greenhouse gas emissions);
- Environmental costs incurred by generating secondary or tertiary waste streams produced as a result of phase-transfer of contaminants (e.g., air discharges, landfill requirements);
- Costs associated with resource consumption or loss (e.g., need to provide for in-kind replacement or compensation for a damaged natural resource, need to dispose of treated material with no immediate beneficial use);
- Stakeholder perception costs associated with different expectations and values (e.g., effort and time required to improve knowledge base and improve consensus, perceived impact on agency's reputation as a result of negative press coverage); and
- Other indirect costs (e.g., real or perceived risks to other programs as a result of a certain action, real or perceived loss in value of impacted resource, or litigation costs).

DLA notes that many of the indirect costs may be directly proportional to the degree to which stakeholders believe that is necessary, feasible, or reasonable to achieve "restoration" of impacted environmental resources in a reasonable timeframe; decisions focused on restoration may represent a low benefit/cost ratio.

Transactional costs of any decision often are not fully recognized in the CERCLA response-action planning process. Yet these kinds of costs are a necessary element of verifying protectiveness, and often represent long-term commitments to ensure protectiveness. Transactional costs are directly related to the level of complexity required to:

- Assess and monitor performance of any specific remedial technology/approach, and
- Fulfill administrative compliance reporting requirements or other agency-specific performance monitoring requirements (e.g., verifying current cost-to-complete estimates).

In general, the nature and scope of engineered controls will drive the nature and scope of transactional costs to be incurred by DLA. Transactional costs associated with administrative/legal controls may be divisible with other involved government agencies (e.g., state groundwater well permitting programs).

Understanding the full costs (or risks) associated with a specific decision is an important check on the "protectiveness" of certain ARARs and remedial technologies and strategies under site-specific conditions. DLA recommends compiling such information to help validate established or proposed RAOs that must be achieved to document "protectiveness." DLA is committed to achieving and sustaining reliable protection; this means that each response decision should be evaluated to determine that it will not result in more risk (costs) than benefits.

2.5.2 Fund-Balancing Test

The second test of reasonableness is embodied in the fund-balancing waiver. For Superfund-led sites, an ARAR may be waived and replaced with an alternative performance objective if compliance would be costly relative to the degree of protection or risk reduction likely to be attained and if the expenditure would jeopardize implementation of remedial actions at other sites. This waiver currently is not available to lead Federal agencies other than USEPA (per statutory language restricting its use to Fund-financed projects only).

However, the fund-balancing statutory test is important in terms of evaluating how best to satisfy response commitments involving significant project costs that are driven by attempts to comply with similar performance objectives or cleanup expectations. Such information feeds into ongoing DLA efforts to update DERP expectations.

2.5.3 Inconsistent State Application Test

The third statutory waiver related to the test of reasonableness is based on the inconsistent application of state requirements, wherein a state ARAR can be waived if evidence exists that the requirement has not been applied to other sites (under CERCLA or any other regulatory program) or has been applied inconsistently. This waiver is intended to prevent unjustified or unreasonable state restrictions from being imposed at CERCLA sites. Use of this statutory waiver may complicate future regulatory coordination efforts and create public acceptance issues. However, this type of statutory performance test could be considered during negotiations as one of the lines of evidence of the "reasonableness" of certain decisions.

Section 3

Developing Comparative Benefit/Cost Ratios

Response-action completion strategies always are focused on results (i.e., protection of human health and the environment). Because every decision made during planning results in an outcome or consequence, the response-action planning process under CERCLA uses formal decision/consequence analysis (DCA). The goal of effective decision-making is to maximize the benefits and minimize the costs of any selected course of action. Thus, the selection of any specific completion strategy requires a transparent assessment of the costs to be incurred by that action against the expected benefits. The response planning process is intended to identify feasible and reasonable approaches to achieving necessary protectiveness (benefits) in a reasonable timeframe, as cost-efficiently as practicable.

DLA is issuing this Guide to clarify that all anticipated benefits and costs must be accounted for through the response-action planning and implementation process. This ensures that any strategic response-action completion plan developed for and/or implemented at DLA facilities maximizes real benefits achieved for minimal cost. This type of strategic planning process, which includes a well-articulated benefit/cost analysis, is required by GPRA, DoD's Strategic Plan, the DERP, and all major environmental laws (e.g., CERCLA).

This section briefly reviews one way to construct a qualitative benefit/cost analysis to clarify stakeholder performance expectations. This Guide is intended to help environmental project teams consider alternative ways of looking at and improving the response decision process; thus, this section is meant as an example only and is not intended to be definitive or all-inclusive. A benefit/cost analysis is an important part of the response-decision process because it defines essential site-level information that will be identified, compiled, and used to evaluate progress toward successfully completing any decision. Such essential site-level information is important to validating or improving both the performance objectives and the means used to achieve those objectives. This information provides the framework to incorporate lessons learned on remedy performance and full costs to improve the benefit/cost ratio of any decision.

3.1 Estimating the Benefits of a Decision

Response-action completion strategies, which are first developed in the pre-decision documents and established in the ROD, are an educated guess on how best to achieve necessary protection in a reasonable timeframe. Thus, the ultimate benefit of any response-action strategy is protectiveness of human health and the environment.

As noted in Section 2.3.1, protectiveness is a general concept that can be expressed by different metrics. DLA recommends using the previously-described protectiveness metrics of short-term protection, long-term protection, permanence, reasonable time, and acceptance when identifying and assessing the benefits of response actions at

DLA sites. These simple protectiveness metrics are part of the recommended decision criteria to be used to select an appropriate response action under CERCLA.

DLA anticipates that most pre-decision planning documents or RODs have not clearly summarized the site-specific assessment of potential **benefits** that are expected as a result of selecting a specific response action. The metrics of protectiveness should be articulated as part of the **basis for taking action,** because this information is crucial to documenting initial performance expectations. This same information should be used to conduct periodic performance evaluations to track progress toward complying with initial performance expectations over time. Failure to achieve the targeted level of benefits (i.e., protectiveness) in a reasonable timeframe will prompt adjustments to improve performance and selection of results-based contingency actions, because DLA is committed to achieving and documenting protectiveness as quickly as possible.

Although the absolute value of a particular benefit resulting from implementation of a response action may be difficult to quantify, the relative value of the benefit may be readily apparent. For example, enforcement of LUCIPs or exposure controls at a contaminated site may result in the immediate attainment of complete protection of human health and the environment within the enforcement area. This result represents the greatest level of protectiveness (hence, the greatest benefit) available. On the other hand, a response that results in "No Action" will provide no protection (hence, no benefit) at the same site. Other possible responses could attain relative protectiveness that might be characterized as "low degree" or "intermediate degree" of protection (corresponding to least benefit and intermediate benefit) for those responses. Consequently, an array of potential response actions can be developed and ranked according to the total relative benefit that each provides.

Appendix A illustrates one method of clarifying the relative value of the benefit achieved by different response-action strategies. In order to specify the value-added by different remedial components, the project team must first identify the potential benefits that are expected by different elements of the response-action decisions.

For example, ranking matrices can be used to comparatively evaluate the relative benefits associated with various soil and groundwater response strategies (Appendix A). The matrices assign relative values of each of five potential response-action benefits (short-term protection, long-term protection, permanence, time required, and acceptance) to potential response-action components for contaminated soil (Table A1) and groundwater (Table A3). The relative benefit assigned to a particular response-action component is based on the level of performance qualitatively anticipated for that component under most general circumstances.

DLA desires a clear assessment of the relative benefit achieved by proposed, in-progress, and completed response actions as a means of validating whether protectiveness has been achieved, and—if not—developing strategic plans to increase the protectiveness afforded by the decision. If, however, protectiveness has been achieved and can be documented, DLA is interested in documenting RC (i.e., protectiveness achieved), and beginning to evaluate cost-efficient ways to verify that reliable protectiveness is being sustained by the decision.

3.2 Estimating the Costs of a Decision

As discussed in Section 2.5.1, costs to be incurred by any response-action strategy can be expressed as direct costs, indirect costs, and transactional costs. Unfortunately, the actual direct and indirect monetary costs of response implementation often are difficult to develop; and other "costs," including loss of beneficial use of a resource as a consequence of remedy implementation (e.g., groundwater removed from the subsurface using an extraction system is no longer available for use) and risks associated with remedy implementation (e.g., potential worker exposure during a removal action) are extremely difficult to quantify. However, it is not necessary to monetize direct, indirect, or transactional costs (or risks) in order to compare them qualitatively.

Similar to benefits, the relative costs of different response-action technologies/strategies can be assigned a simple rank (see Appendix A). For example, the direct costs associated with aggressive engineering treatment systems can be expected to be relatively higher than the direct costs incurred by engineering containment systems. The direct costs of this technology may be ranked higher than other strategies. However, when indirect and transactional costs—which include potential impacts on other resources (see Section 2 of this Guide)—are considered, the total costs of different remedial technologies and approaches may change. The cost of not taking any action at all—which may include increased costs associated with land use controls over time if containment is not maintained—should be clarified.

Ranking matrices can be used to assign relative values for direct, indirect, and transaction costs to potential response-action components for contaminated soil and groundwater (Appendix A). The relative cost assigned to a particular response-action component is based qualitatively on the costs anticipated for implementation of that component under most general circumstances, and ranges from 0 (no cost) to 3 (greatest cost).

DLA anticipates that most pre-decision planning documents or RODs have not clearly summarized the site-specific assessment of potential **full costs** that are expected to be incurred as a result of selecting a specific response action. The costs of pursuing protectiveness should be articulated as part of the **basis for taking action,** because this information is crucial to documenting initial performance expectations. Similarly, this information is critical to conducting periodic performance evaluations and making determinations about the long-term cost-effectiveness of different technologies and approaches.

3.3 Benefit/Cost Analyses

The relative benefits and costs of different response completion decisions can be graphically illustrated, to demonstrate the relative effectiveness of different technologies in terms of providing the necessary protectiveness. For example, in many cases, "restoration" objectives define the compliance commitments made by the lead Federal decision agency. These performance objectives may not be necessary to assure protectiveness at the current point of exposure; these types of performance objectives represent a desire to "recover" degraded environmental resources to pre-release conditions.

Additionally, “restoration” objectives may not be achievable given the demonstrated effectiveness of current remedial technologies. As a consequence, impracticable compliance commitments may be made, which means that protectiveness—as defined by the RAOs stipulated in the decision documents—cannot be achieved or documented in a reasonable timeframe. The relative benefits achieved by expended costs often cannot be justified in these situations.

For example, a benefit/cost comparison for a hypothetical response decision focused on achieving restoration as the final performance requirement for protectiveness could indicate that the degree of protectiveness does not depend on the effectiveness of mass-recovery techniques or *in-situ* restoration methods; rather, protectiveness is provided through time at the point of exposure via engineered and/or administrative/legal controls. This means that—in order to document protectiveness—the decision would need to recognize the benefits realized by feasible source reduction and reliable, long-term *ex-situ* controls. The benefits of pursuing a restoration RAO, which is desirable only to limit the long-term need for current ex-situ controls, are offset by the costs (impracticability) of available remedial technologies. Continued pursuit of restoration as the final RAO will lead to noncompliance with that RAO, and will prevent achieving RC.

As discussed earlier, simple ranking methods can be constructed to comparatively evaluate the relative benefits and costs of alternate decisions (Appendix A). A benefit/cost analysis begins with compiling the relative benefits and costs associated with particular response actions. All specific components of the decision should be included (RAOs and remedial techniques). As illustrated in Appendix A, simple ranking numbers can be assigned to several possible remedial components for each of the five protectiveness metrics. These ranking numbers can then be combined for multi-component response actions. For example, a removal action to address soil in a contaminant source area may combine the component of in-situ oxidation with a component of legal or administrative controls to prevent public access to the source area before or during implementation of the in-situ oxidation component.

The relative benefits and relative costs of the type of multi-component response-action can be derived by combining the ranking numbers of each of the components to yield a total relative benefit and total relative cost for the complete response action. This example is illustrated in Table A5 of Appendix A where the individual component ranking numbers are combined according to the following rules:

- Benefits are regarded as non-additive within a given protectiveness metric – that is, combining a component having the least relative benefit with a component having an intermediate relative benefit will not produce a response action having more than an intermediate relative benefit for a given protectiveness metric. Accordingly, in Table A5, the largest relative benefit provided by either of the two components of the complete response approach is identified for each of the five protectiveness metrics. The benefit ranking numbers thus chosen are, however, then combined to rank the total response action by adding them across the five categories of protectiveness metrics to produce the "Total Relative Benefit" for the complete response action.

- Costs are regarded as additive – that is, certain identifiable costs are associated with each component of a response action, and these costs are cumulative as the response is developed and implemented. Accordingly, all costs for each component of the response approach are identified for each cost type (shaded cells in Table A6, Appendix A), and these are summed to produce the "Total Relative Cost" for the complete response action.

After relative total benefits and relative total costs have been estimated for one or more complete response actions, these values can be used to generate a benefit/cost ratio for each potential response action. Benefit/cost ratios generated for several potential response actions at a particular site then can be ranked, and used to evaluate the relative applicability of each potential response action in successfully addressing conditions at the site. Various combinations of response-action components also can be tested using this procedure, to develop response approaches that provide the greatest relative benefit at a site, while reducing the incremental relative costs necessary to achieve that benefit.

This procedure was developed as an illustration; use of such a screening-level evaluation tool requires professional judgment and up-to-date knowledge about industry-wide operating experience. The greatest advantage of the procedure derives from its ability to combine several weighting factors, associated with performance evaluation criteria, into a single numerical score, which allows alternatives to be simultaneously ranked according to how well they satisfy <u>all</u> performance criteria for a decision. Moreover, the approach is readily adaptable to changing response-action technologies or approaches, and to site-specific conditions, making it a useful tool for iterative performance assessments. For example, it is possible that improvements in a particular technology (e.g., *in-situ* oxidation) might result in improved performance of the technology, while reducing overall cost of application. In such circumstances, the relative benefits and relative costs in the matrices could be adjusted to better reflect technology-specific or site-specific information.

3.4 Articulating the Basis of Protectiveness and the Justification for Costs

DLA recommends using straightforward (and therefore easy to explain) benefit/cost ratios ***to clarify and justify the basis of any decision.*** Benefit/cost ratios can be used to clarify the feasibility and reasonableness of achieving certain RAOs at different compliance points (e.g., restoration RAOs throughout the impacted environmental medium within a reasonable timeframe). Note that the necessity of taking action to prevent unacceptable exposure at reasonable points of exposure is established by credible risk assessment techniques. Often, however, development of the RAOs is based on unreasonable assumptions about potential exposure (e.g., all impacted groundwater will be a source of untreated drinking water) or on unreasonable expectations regarding the feasibility of achieving certain objectives (e.g., restoration by current remedial technologies can be achieved in a reasonable timeframe).

Most response decisions include some form of engineering or administrative/legal controls that provide for immediate and effective protection. Those controls will remain in place as long as they are required to maintain and verify protectiveness. Often, the duration through which those controls are necessary is defined by the feasibility of restoration (i.e., until mass removal as been achieved to a degree such that no controls or restrictions are required). Benefit/cost ratios can be used to evaluate the degree to which various responses may achieve spatial and temporal RAOs that afford equivalent levels of protection (benefits), together with associated relative costs. Thus, a site- and response-specific benefit/cost ratio can be developed to assist in selection of ARARs and/or the derivation of protective alternate concentration limits (ACLs), as well as support the selection and optimization of the means to achieve the RAOs. This analysis can be used to clarify how all the metrics of protectiveness are and will be satisfied by the current or proposed response-action decision. **Establishing necessary, feasible, and reasonable RAOs that can be satisfied in a reasonable timeframe is the foundation of achievable completion plans**.

For example, current site conditions may be protective in the short term, provided that adequate engineering and administrative/legal controls are in place to prevent unacceptable human exposures or further environmental degradation. In this case, the protectiveness metrics that can be initially satisfied by **short-term RAOs** include short-term protection, reasonable time, and stakeholder acceptance; the relative benefit achieved by attaining these RAOs depends upon interrupting potential exposure pathways and containing/controlling sources. Thus, **long-term RAOs** must satisfy only the protectiveness metrics of long-term protection and permanence; both of these metrics hinge on the definition of "reliable."

The common perception of what constitutes reliable protectiveness appears to be derived from the statutory preference for permanent, treatment-based remedies. As a consequence, long-term RAOs are based on the perceived need to achieve resource restoration in order to demonstrate reliable protectiveness. Although a desirable goal, practical experience with currently available remedial technologies in certain site conditions calls into question the feasibility and reasonableness (or practicality) of achieving such "reliability" in any reasonable timeframe. Until restoration is achieved, all metrics of protectiveness are satisfied by other means (e.g., administrative/legal controls, engineering controls at the point of exposure). Thus, the benefit/cost ratio of attaining "restoration" RAOs is defined simply by the full costs incurred to achieve that degree of reliability.

Benefit/cost ratios also can be used to clarify the relative costs associated with different means of providing equivalent levels of protectiveness, and the relative benefits provided and relative costs incurred can be evaluated for various response components to help identify appropriate responses.

3.5 Hypothetical Relative Benefit/Cost Analysis Example

To illustrate, the concepts described above are examined using the tables provided in Appendix A to develop a hypothetical case example of a site where volatile contaminants are present in soil in the vadose zone. Site conditions are such that four response actions are regarded as feasible and reasonable means to provide protectiveness:

- Excavation and *ex-situ* treatment or disposal of contaminated soil, with legal/ administrative controls;

- Soil-vapor extraction (SVE) of contaminants from the vadose zone, with legal/ administrative controls;
- In-situ thermal treatment of contaminants, with legal/administrative controls; or
- Isolation/containment of contaminants, with legal/ administrative controls.

In addition to these active approaches, the No Action option also is considered, as required by the NCP.

The relative benefits and relative costs associated with each potential response action for the site can be estimated, using the ranking procedures outlined previously. Details on the benefit/cost ranking process are presented in Appendix A. Selection of the No Action approach produces no relative benefits at the site, although this approach is not without costs. As a consequence of the resulting zero relative benefit, implementation of the No Action approach would produce the lowest benefit/cost ratio (0.00) of any of the potential responses considered. Selection of any of three other potential response actions—excavation and *ex-situ* treatment or disposal of contaminated soil, with legal/administrative controls in place, SVE, with legal/administrative controls in place, or isolation/containment of contaminants, with legal/administrative controls in place—would produce relatively high levels of total relative benefits (13 for each approach), indicating that **implementation of any of these three approaches would provide an equivalent level of protection at the site**.

However, the relative costs associated with each of these three approaches vary somewhat, so that the benefit/cost ratios for the three approaches are different. In the situation under consideration, the approach that includes excavation and *ex-situ* treatment or disposal of contaminated soil appears to provide the greatest relative benefit (reliable protectiveness) for the lowest relative incremental cost (i.e., this approach has the highest benefit/cost ratio), and probably should be selected for implementation. The last remedy considered—*in-situ* thermal treatment of contaminated soil, with legal/ administrative controls—apparently provides a lower total relative benefit, at the highest relative cost of any of the approaches considered.

Few approaches involving engineering controls alone are fully protective prior to complete implementation; and the long-term protectiveness of any engineering control is not assured until RAOs have been achieved. On the other hand, imposition of legal or administrative controls may be the most efficient means of achieving immediate and effective protection in the short term, and through the duration of response implementation (long-term protection). This is reflected in the benefits-ranking matrices (Tables A1 and A3, Appendix A), which assign a value of 3 (Greatest Benefit) to the benefits resulting from short-term and long-term protectiveness associated with legal/ administrative controls. Therefore, all response approaches considered in this hypothetical example include some form of administrative/legal controls.

The relative effects associated with imposition of administrative/legal controls also can be examined using the hypothetical example above. Selection of *in-situ* thermal treatment of contaminated soil, with no legal/administrative controls in place would produce a total relative benefit of 3 – the lowest for any approach at the site except No Action (Table 1). Although some cost savings would result from not providing legal/administrative controls, failure to implement controls of this nature would produce a total benefit/cost ratio less than one-half that produced by the same engineered approach with legal/administrative controls in place. This result suggests that neglecting legal/administrative controls is an example of false economy, and that all implemented response actions always should include some element of legal/administrative controls.

This benefit/cost analysis approach can be tailored to address site-specific, contaminant-specific, and location-specific considerations. For example, the benefits resulting from implementation of a particular response action may vary depending upon location relative to a contaminant source. Thus, a range of benefit/cost ratios may be estimated for responses applied at a number of different potential exposure points at a particular site. This would enable a manager to identify the best location(s) for implementing a particular approach.

3.6 Building Balanced and Flexible Response Decisions

Response-action planning often is viewed as a deterministic process, whereby there is a single path to a single "successful" solution. Deterministic planning does not address the possibility that the planned or implemented actions may not produce the outcomes anticipated or expected. Efforts to minimize costs have focused on adopting a precision approach to ensuring successful completion of response-action obligations; this means that planning efforts do not explicitly account for the probability of failure (e.g., failure to document protectiveness, failure to maintain a high benefit/cost ratio).

In order to deal with the uncertainty associated with evolving scientific knowledge and technological capabilities, the response decision could be presented in the form of a probabilistic rather than a deterministic plan. The possibility for optimization, improvement, and/or replacement thus becomes an integral part of the decision, so that any decision can be improved as knowledge about site conditions, contaminant toxicity, and remedy performance improves.

A probabilistic response decision is designed to stipulate the potential for and suitable contingency responses to various possible outcomes of an action. A probabilistic response decision can be used to clearly specify performance decision criteria, including measurable attributes of any element of the decision that would trigger implementation of an optimization opportunity (e.g., innovative field investigation approaches, ARAR analyses to support alternative RAOs, technology assessments to optimize the means).

A probabilistic completion plan—or exit strategy—is characterized by the use of decision trees. Decision trees are constructed to describe "if—then—because" actions as a means of clearly articulating the basis and justifiable scope of performance improvements. Decision trees map all options and potential consequences in a manner that is easy to understand and explain to stakeholders. The decision tree illustrates the basis of the decision and the decision criteria used by the project team to define performance and non-performance. Although the statutory tests of performance (Section 4) limit the general scope of information that should be considered in site-specific performance decision criteria, the specific metrics and triggers to be used to guide decision improvement efforts are highly site specific.

DLA is not promoting the use of probabilistic planning efforts to lead to RAOs that are less stringent than those required to afford the level of protection desired by all stakeholders. Rather, this Guide is designed to help environmental project teams guide stakeholders through the logic required to make better decisions over time as their knowledge improves. Decision-analysis techniques, such as decision trees, are useful tools that can be used to help structure complex decisions, and make use of improving knowledge about whether the initial decisions were "right" or "wrong" to improve the decision over time. The intended outcome of this kind of planning is to use lessons learned to develop **achievable** RAOs; achievable performance goals lead to achievable response-complete plans.

For example, if the rate of removal of contaminant from an aquifer by a treatment system is greater than predicted, the cost-to-complete and schedule-to-complete estimates may need to be modified as a result of practical experience. DLA needs this kind of essential site-level data to validate current environmental liability statements. Conversely, if the rate of removal is less than predicted, the performance objectives (i.e., the RAOs and ARARs) of the decision should be re-assessed in the context of evolving knowledge for necessity, feasibility, and reasonableness. Figure 4 is a site-specific example of a response-action completion strategy that includes self-executing performance decision criteria.

If sufficient site-specific data are available to justify an alternative level or standard of control, the probabilistic plan can be used to communicate the basis of refining the ARAR analyses and resultant RAOs. Any recommended changes to the means used to efficiently achieve those RAOs also can be presented, particularly as such changes may be relevant to the statutory tests of feasibility and reasonableness. The DLA policy requiring the formulation and implementation of an exit strategy is presented in Appendix C.

3.7 Incentivizing Performance

This Guide requires environmental project teams to clearly articulate metrics used to evaluate performance of response decisions through time. DLA environmental project teams may wish to use this information to establish **performance-based cleanup contracts (PBC^2)** to inspire and reward creative solutions and measurable performance. These kinds of cleanup contracts are built around clear performance objectives and decision criteria (e.g., specified benefit/cost ranges) incorporated into a well-articulated completion plan.

A PBC^2 is a unique contracting mechanism that is designed to contractually define results so that performance can be easily measured. PBC^2 is like PERMA: quite straightforward in principle, and more challenging in practice. PBC^2 inspires contractors to perform by providing full payment, and possibly a bonus, upon meeting or exceeding the standards of performance. In turn, falling below the standard of performance can lead to either payments being withheld until the standard is met, or payments being decreased because of poor performance. PBC^2 is designed to shift the focus of management away from staffing and activity and toward creative solutions that bring measurable results, which should increase accountability and accomplishments.

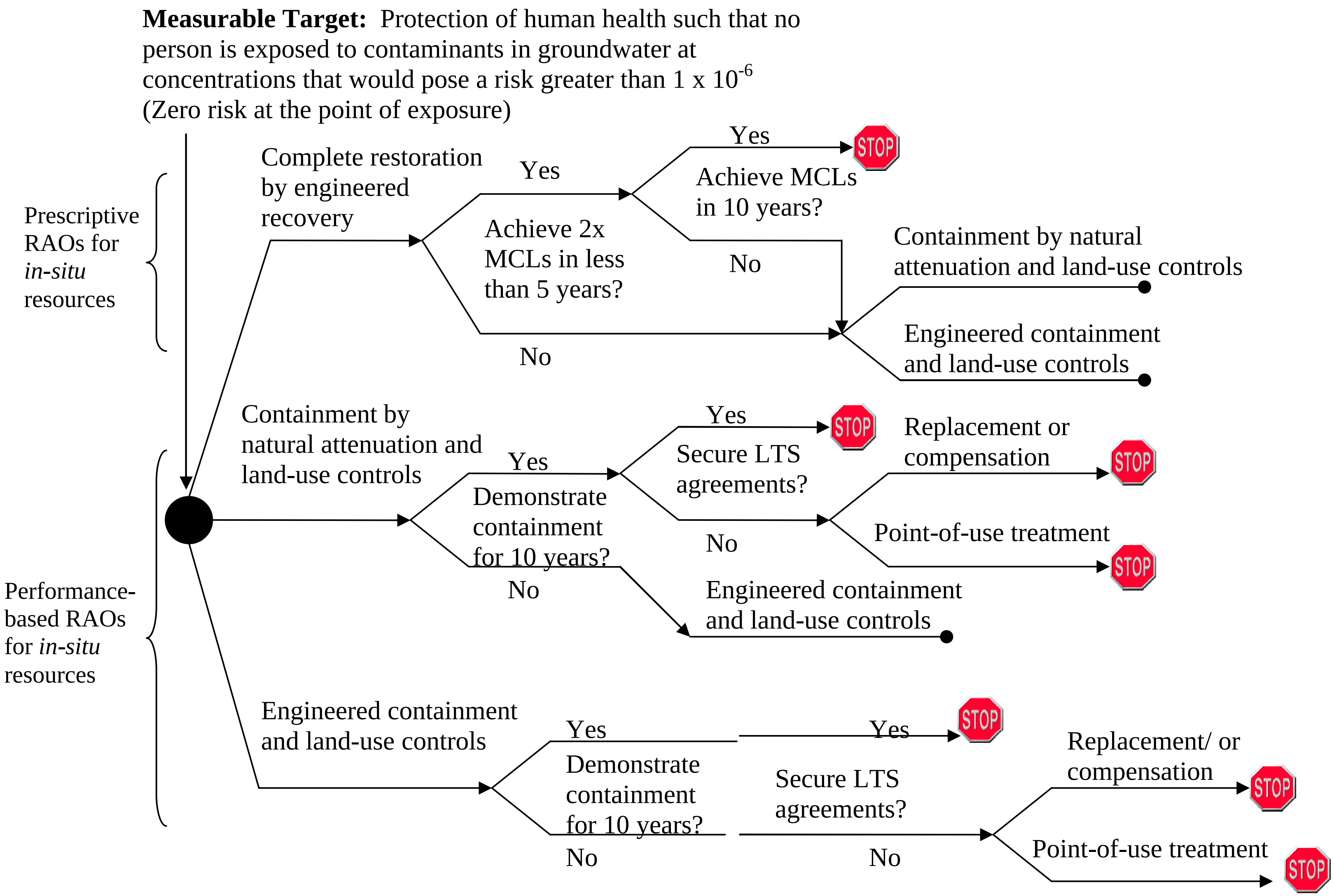

Figure 4. Example decision tree with alternative yet protective uncertainty management strategies linked to provide effective and efficient closure approach.

Table 1. Example Relative Benefit/Cost Evaluation of Potential Response Actions to Address Contaminated Soil

Potential Complete Response Action	Benefit	Cost	
	Relative Benefit[a/]	Relative Cost[b/]	**Benefit/Cost Ratio**[c/]
No Action	0	6	0/6 (= 0.00)
Excavation and *Ex-Situ* Treatment/Disposal with Legal/Administrative Controls	13	24	13/24 (= 0.54)
SVE[l/] with Legal/Administrative Controls	13	32	13/32 (= 0.41)
In-Situ Thermal Treatment (no Legal/Administrative Controls)	3	27	3/27 (= 0.11)
In-Situ Thermal Treatment with Legal/Administrative Controls	11	39	11/39 (= 0.28)
Isolation/Containment with Legal/Administrative Controls	13	30	13/30 (= 0.43)

[a/] Relative benefits of each of the components of a potential response action are assigned on the basis of Table 1. As each of the five relative-benefits factors is considered, the greatest value of that factor occurring in any component of a particular response action is used as the value of the relative benefit of that factor for the response action (refer to Table A.5); and the total relative benefit resulting from implementation of that response action is the sum of the relative benefits for each of the five relative-benefit factors.

[b/] Relative costs of each of the components of a potential response action are assigned on the basis of Table 2. The total relative cost resulting from implementation of a particular response action is the sum of all of the relative cost factors of each component of the potential response action (refer to Table 6).

[c/] Benefit/cost ratio for a particular response action is the ratio of the total relative benefit anticipated to result from implementation of the response action, and the total relative cost associated with implementation. The preferred response action is that which provides the greatest relative benefit for the least relative cost (i.e., has the highest benefit/cost ratio).

[d/] SVE = soil-vapor extraction.

Section 4

Developing Achievable Response-Complete Plans: Completing ARAR Evaluations

As a matter of DoD policy, response actions to correct environmental damage that poses an imminent and substantial endangerment to the public health, welfare, or the environment are conducted in accordance with the provisions of CERCLA, the National Oil and Hazardous Substances Pollution Contingency Plan (NCP), and related Executive Orders (DoD, 2001). This Federal response decision process is intended to be sufficiently flexible to allow improvements through time as the knowledge base improves.

The response-action planning and implementation process often is incorrectly considered to be linear, which means that the process would be based on a deterministic decision model (i.e., the first answer is the only "right" answer). However, the response-action decision process was designed to allow meaningful incorporation of evolving knowledge. Thus, newly acquired information should be used to improve the performance (protectiveness) of the decision through time. Information developed throughout the response-action planning and implementation process should be used to verify that the basis, nature, and scope of the decision are and remain justifiable (i.e., necessary, feasible, and reasonable), and that the proposed or implemented decision is and continues to be the most effective and efficient way to protect human health and the environment.

For instance, periodic performance evaluations—which are mandated by law for certain situations (e.g., CERCLA 5-year reviews, as required by §121[c])—provide the opportunity to analyze evolving site characterization and remedy performance data to verify the **basis of and need for** the response-action, including the degree of cleanup required to protect human health and the environment. Although the need for abatement and additional response action should be assessed, these periodic performance evaluations also represent an opportunity to iteratively refine the RAOs and the means used to achieve those RAOs that were believed to be necessary, feasible, and reasonable to complete in a reasonable timeframe when the decision was first made.

Thus, DLA requires environmental project teams to use an exit strategy model during remedy planning and periodic performance evaluations. Such a model can be used to compile and communicate substantive evidence relevant to defining, refining, and completing achievable response-action decisions in a reasonable (e.g., 10-year) timeframe. DLA has been specifically directed by the DERP and its implementing guidance to evaluate the need for and scope of environmental response requirements, especially considering:

- Health assessments and risk assessments (i.e., test of necessity);

- Capabilities and effectiveness of available remediation technologies for characterized site conditions (i.e., test of feasibility); and
- Time and cost required to complete obligations (i.e., test of reasonableness).

DLA has issued this Guide to clarify that evolving knowledge should be systematically and continuously subjected to the statutory tests of performance to steer efforts to implement and improve complex closure decisions as the knowledge base expands. DLA requires environmental project teams to use the statutory tests of performance to identify and articulate defensible, measurable decision criteria that will be used to document protectiveness in a reasonable timeframe.

DLA also requires that the principles of PERMA be applied when evaluating and reporting on project and program performance, and when preparing CTC and STC estimates for known response-action obligations.

4.1 The Role of ARARs and Achievable Completion Plans

DLA believes that the importance of the ARAR evaluation process has not been clearly articulated, even in various USEPA guidance documents (e.g., USEPA, 1989a, 1991, 1998). Although guidance on how to <u>identify</u> potential ARARs is available, little information has been developed on how to <u>evaluate</u> and select ARARs and establish achievable RAOs. The absence of this kind of guidance may lead environmental project teams to incorrectly conclude that *identification* of ARARs requires compliance.

Data compiled to support response-action decision selection <u>and</u> periodic performance review are critical to evaluating whether specific ARARs stipulate the necessary, feasible, and reasonable level of protectiveness to target as substantive compliance and completion criteria. Much of the substantive evidence required to defend an alternative standard or level of control, as afforded in CERCLA §121(d)(4) and most state environmental cleanup laws, may not have been readily available early in the cleanup program, particularly with regard to the tests of feasibility and reasonableness. However, as the Federal and state cleanup programs have matured, the knowledge base has expanded dramatically. This evolving information may be directly relevant to updating the ARAR analyses, to verify that DLA has not and will not commit to response-action completion strategies that are unnecessary, infeasible, or unreasonable.

Consequently, periodic performance reviews should begin with a review of the site-specific and general information related to the ARARs that form the foundation of the targeted RAOs. A detailed review of the RAO development process, including the initial ARAR analysis, should be presented in both the pre-decision planning documents and the ROD. Periodic performance evaluations should include compiling and critically re-examining information relevant to a determination of the legal applicability and relevance <u>and</u> appropriateness of any identified pertinent standard, requirement, criteria, or limitation that may scope the nature and extent of response-action obligations. The statutory tests of performance should be explicitly considered when making or evaluating determinations regarding applicability, relevance, and appropriateness to site-specific conditions.

The following subsections summarize the general steps that could be taken to apply the statutory tests of performance to establish the need to comply with or waive ARARs selected for a given site. The objective of this effort would be to compile and communicate substantive evidence relevant to:

- Justifying and leveraging legally allowable regulatory flexibility regarding RAOs (i.e., protectiveness criteria) and cost-efficient means to achieve those RAOs; and
- Efficiently reacting to evolving information on the necessity, feasibility, and reasonableness of certain response-action strategies and requirements.

4.2 Step 1: ARAR Identification

DoD solicits regulatory agency input with regard to candidate (potential) ARARs during the response-action planning process. This input should be documented in the AR. This regulatory agency input marks the beginning of the ARAR analysis effort. As lead Federal agency, DLA is solely responsible for establishing final response-action obligations to meet the ultimate performance objective of the DERP—protection of human health and the environment in a reasonable timeframe.

No regulatory agency may establish the environmental liabilities for DoD, unless such agency establishes, in the AR, that alternative RAOs and/or alternative means to achieve those RAOs are necessary, feasible, and reasonable to achieve protection within a reasonable timeframe. USEPA or the state would need to present substantive evidence to justify a response-action decision that differs from that selected by the lead Federal agency. Disagreements regarding substantive compliance requirements (i.e., the RAOs and ARARs) can be resolved in accordance with existing interagency agreements or, if necessary, in the Federal District Court for the district in which the DoD facility is located.

DLA has determined, based on conducting periodic performance evaluations (i.e., RPO Phase II evaluations and five-year review reports) at many facilities, that site-specific information relevant to the necessity, feasibility, and reasonableness of candidate (potential) ARARs suggested by the regulatory agencies often is not compiled or presented clearly within the AR. Also, emerging technical information relevant to the statutory tests of performance is not clearly linked to assumptions made during the planning and implementation process.

Consequently, DLA recommends that environmental project teams use the ARARs that form the basis of the proposed or targeted RAOs as the guide to identifying substantive data relevant to legal applicability, and use best professional judgment (including application of the tests of necessity, feasibility, and reasonableness) in determining the relevance and appropriateness of those ARARs. Or, more clearly, start the planning or performance review process with the targeted goal in mind.

4.3 Step 2: Legal Determination of Applicability

The next step is to define or verify legal applicability. A pertinent standard may be either “applicable” <u>or</u> “relevant *and* appropriate,” but not both. In order to be legally applicable, the standard must be promulgated under Federal or state law. The term "promulgated" means that the standard is in a law or regulation that is legally enforceable (i.e., the issuing agency has the legislative power to issue such rules). Guidance and advisories are not considered "promulgated" because they are not legally enforceable (e.g., they are interpretive “rules” or policy statements).

A pertinent standard is applicable only if it directly and fully addresses the situation at the site. To be applicable, all jurisdictional elements also must apply. The question of applicability is a legal one, so the environmental project team should seek legal counsel if necessary.

As an example, the National Primary and Secondary Drinking Water Standards (MCLs) are promulgated standards that are legally enforceable for the circumstances for which they were issued. These Federal MCLs are designed to regulate specific chemicals in public water supply systems that have at least 15 service connections or serve at least 25 year-round residents. This means that the Federal MCLs define the allowable concentration in public drinking water supplies at the tap following any necessary treatment. These standards were not designed to address the circumstances at most CERCLA sites, or to define necessary, feasible, and reasonable cleanup standards for *in-situ* resources. Federal MCLs usually are not legally applicable for response-action decisions for *in-situ* groundwater resources. These standards should be evaluated for relevancy and appropriateness.

In many cases, however, states have adopted the Federal MCLs as part of their groundwater cleanup and anti-degradation requirements. These state standards may be legally applicable. State anti-degradation laws typically cannot be used to require cleanup to the aquifer’s original quality prior to contamination, because these laws are prospective and are intended to prevent *further* degradation of groundwater quality. However, anti-degradation statutes may be applicable to state waters that are currently unaffected by site contaminants, but that may in the future be threatened by migrating contamination.

State cleanup laws could stipulate targeted cleanup standards for groundwater, which should match the anticipated beneficial uses of that water. Most state cleanup laws clearly recognize the potential impracticality of meeting those standards (e.g., in specific waiver provisions or use of the clause “as practicable”). An initial or continuing decision to pursue compliance with these applicable standards should be supported by substantial evidence of the necessity (e.g., beneficial use determination), feasibility (e.g., demonstrated evidence of likelihood to achieve the stipulated degree of cleanup in a reasonable timeframe, given the capabilities and measurable effectiveness of current remedial technologies), and reasonableness (e.g., benefit/cost analysis considering resource replacement or point-of-exposure treatment costs).

4.4 Step 3: Best Professional Judgment on Relevance and Appropriateness

A requirement that is not legally applicable may be relevant and appropriate if it addresses problems or pertains to circumstances that are sufficiently similar to those encountered at the specific site (relevant) and are well-suited (appropriate) for application at the specific site (§300.5 of the NCP). Note that a requirement can be relevant but not appropriate. For instance, 40 CFR §§61.147 and 61.152 establish procedures for asbestos emission control and waste management during demolition of buildings or equipment containing friable asbestos material. This regulation may be noted as relevant to response-action decisions regarding residual asbestos in soil impacted by past demolition activities, but may not be determined to be appropriate for application because such standards are not well-suited to the specific conditions.

Only those requirements that are both relevant and appropriate need be considered in the ARAR evaluation process (USEPA, 1998). Because these determinations typically are made using best professional judgment, the lead Federal agency is afforded significant flexibility and discretion. And, unlike legally applicable standards, the lead Federal agency can determine that only a portion of a promulgated standard is relevant and appropriate (i.e., compliance with all substantive provisions of a pertinent standard may not be required).

DLA requires environmental project teams to carefully and routinely evaluate site-specific and general technical information pertinent to potentially relevant and appropriate requirements. Conclusions regarding the necessity, feasibility, and reasonableness (i.e., the appropriateness) of these types of ARARs will drive efforts to achieve and document protectiveness, and attain RC.

4.5 Step 4: To-Be-Considered Elements

In addition to ARARs, to-be-considered guidelines (TBCs) and other controls may be used in conjunction with ARARs to define the necessary, feasible, and reasonable RAOs and/or means to achieve those RAOs. TBCs are not promulgated, and therefore are a category of potentially pertinent requirements, criteria, or limitations distinct from ARARs. For instance, USEPA has noted that statements regarding expectations for the Federal response-action program (e.g., efforts to return usable groundwater to its beneficial uses, wherever practicable, within a timeframe that is reasonable given the particular circumstances of the site; §300.430[a][1][iii][F]) are not "binding requirements," which may mean that such policy interpretations are TBCs.

DLA anticipates using TBCs to clarify response-action obligations if such guidelines are required to ensure protection at points of potential exposure that may exist under reasonable assumptions (e.g., *CERCLA Compliance with Other Laws Manual* [USEPA, 1989a]). Thus, spatially defined points of compliance should be specified for any TBCs. Any RAO that is built upon a TBC should be accompanied by an explicit explanation of why that "criterion" is necessary, feasible, and reasonable to provide reliable protection of human health and the environment.

4.6 Step 5: Test Pertinent Standards for Necessity, Feasibility, and Reasonableness

Once candidate ARARs have been confirmed to be either applicable or relevant and appropriate, the level or standard of control specified by the ARAR should be rigorously evaluated using the tests of necessity, feasibility, and reasonableness using the best available information. This level of evaluation often has not been completed or is not clearly documented within the AR.

The ARAR evaluation process should be supported by site-specific risk assessment to define risk-based cleanup concentrations. If the site-specific risk assessment indicates that an **equivalent standard of protection** has been or can be achieved with a different standard or level of control than the candidate ARAR, such risk assessments may be considered sufficient evidence to determine that compliance with the ARAR is unnecessary to meet the performance objectives of Federal and state laws and regulations.

Recognizing the very real limitations of certain types of response-action technologies and strategies is a key step in evaluating ARARs for practicality (feasibility and reasonableness). The national cleanup programs are built upon the aggressive but realistic use of treatment methods. Performance data for different response technologies should be clearly linked to performance assessments regarding the practicality of certain ARARs. Note that a determination of impracticability and invoking any of the "impracticability waivers" does not mean that protectiveness cannot be achieved.

For example, the impracticability of reducing contaminant concentrations in an entire aquifer to a specific cleanup standard would shift the focus of response actions to a more realistic point of compliance to achieve the desired protection. In this case, wellhead treatment may achieve protection at the point of compliance without subjecting an entire aquifer to an infeasible standard. A clear benefit/cost analysis should help all stakeholders understand performance objectives and the performance metrics and decision criteria to be used to validate and improve progress toward achieving objectives in a reasonable timeframe.

To test for reasonableness, DLA requires environmental project teams to consider the use of simple comparative benefit/cost ratios when undertaking thorough analyses of the practicality of complying with candidate ARARS. The use of such methods is consistent with certain provisions within governing Federal and state response laws, including the National Environmental Policy Act of 1969 (NEPA) and natural resource damage assessment programs.

The principal test of reasonableness is specifically designed to determine whether compliance with a candidate ARAR could result in **greater risk to human health or the environment** than would compliance with an alternative standard of control. For example, efforts to aggressively contain low-risk groundwater that is discharging into nearby surface water by implementing high-volume extraction and treatment could impact the hydrology and uses of that surface water body. Similarly, installation of an engineered cover that requires destruction of existing habitat and negatively impacts groundwater quality characteristics by eliminating surface recharge may present a greater risk to the environment than would an alternative standard of control. Such responses would be classic examples of the cure being worse than the illness. This information may be used to identify ARARs, and—if necessary—justify waiver of an ARAR.

4.7 Step 6: Communicate the Decision Basis to Stakeholders

The statutory tests of performance are designed specifically to identify and validate the degree of cleanup required by the regulations driving environmental response actions. If the scientific and technical basis of the ARAR analysis are well researched and documented, the results of applying the statutory tests of performance—which ultimately should form the basis of any response decision—should be transparent to all stakeholders.

Thus, DLA supports construction of RODs and response-action performance assessment reports that will serve as the technical due-diligence summaries supporting the proposed or targeted performance goals of the decision. This information serves to answer the question of *why* a particular RAO is appropriate. Technical performance monitoring information related to measurable progress toward those goals then can be used to validate project performance and budget requests through time.

Section 5

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APPENDIX A

Evaluating Relative Benefits and Relative Costs Associated with Response Actions

TO BE ADDED

APPENDIX B

Life Cycle Analysis of Resource Use and Risk

TO BE ADDED

APPENDIX C

Exit Strategy Policy

TO BE ADDED